No. 103 July, 1930

BULLETIN

of the

OHIO STATE UNIVERSITY AGRICULTURAL COLLEGE EXTENSION SERVICE

H. C. RAMSOWER, DIRECTOR

Growing Vegetable Plants

Greenhouses meet all requirements for growing plants.

THE OHIO STATE UNIVERSITY, COOPERATING WITH THE U. S. DEPARTMENT OF AGRICULTURE,
AGRICULTURAL EXTENSION SERVICE, H. C. RAMSOWER, Director, Columbus
FREE—Cooperative Agricultural Extension Work—Acts of May 8 and June 30, 1914

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Growing Vegetable Plants

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Several vegetable crops are grown for the early market that need to be started before the outdoor season opens. Profits from these crops depend in part upon earliness. Growing plants in hotbeds and coldframes is one method by which the market gardner obtains early maturity.

Growing a good plant is too important a part of the vegetable business to entrust to someone else. Little attention has been given to the quality of plants. Buying them may prove disastrous for they are often poorly grown and may carry diseases.

During the past few years the business of growing plants has changed both in cultural practices and in the type of equipment used. This bulletin outlines plans for the economical construction of modern plant-growing equipment and describes the cultural practices needed in the production of good plants.

Soil Sanitation

Disease free soil is needed in the hotbed and in the coldframe. However, it may be possible to use the same soil for a few years without the disease factor becoming serious, if this soil is kept free from weeds and vegetables during the summer and fall.

If the plant-growing structures are to be used during the summer and fall, crops should be grown in them that do not carry diseases of the plants to be produced there in the regular season. The chief objection to weeds growing in the hotbeds and coldframes during the summer is that some of them may carry diseases.

For treating seeds as a means of disease precaution see Agricultural Extension Bulletin 76, Ohio State University, "Control of Garden Insects and Diseases."

Steam Sterilization.—If the soil has been used for a number of years, it may be necessary to replace it or to sterilize it. If it is to be sterilized, steaming is the most satisfactory method.

In using steam sterilization, uniform distribution of heat will require placing 3- to 4-inch drain tile in rows 16 to 18 inches apart from center to center and from 13 to 18 inches from the surface of the soil. The amount of soil which can be sterilized at one time depends upon the boiler capacity. Each horse power capacity of the boiler can be counted upon to sterilize from 3 to 9 square feet of bed.

Steam is admitted through a header pipe. A 3/8-inch pipe nipple extends into the end of each tile line. Thorough sterilization may be secured with a steam pressue of 50 pounds at the boiler

Fig. 1.—A header for steam sterilization showing concrete collars used in connecting header with tile lines.

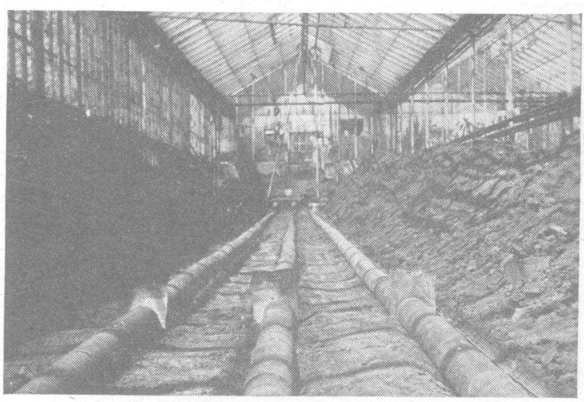

Fig. 2.—Tile lines for steam sterilization can also be used for heating.

in three or four hours time. Equally effective sterilization can be secured with lower pressure but it will require a longer time.

The period of application of the steam will vary from three to eight hours. The beds are covered with canvas before they are steamed and the covering is left on for several hours after the steam is turned off. Thorough sterilization will require a temperature of 160°F. at a point 6 inches beneath the bottom of the tile lines and midway between them. The surface temperature should be at least 190°F.

Tile laid for steam sterilization can also be utilized for heating purposes.

Formaldehyde.—Where steam is not available the most common and safest method of sterilization is with formaldehyde. Four pounds, or pints, of formaldehyde (40 per cent) are added to 25 gallons of water. This solution is applied at the rate of one-half gallon per square foot of ground area. The soil will be soaked to a depth of 6 or 8 inches. It is then covered for 24 to 36 hours. The

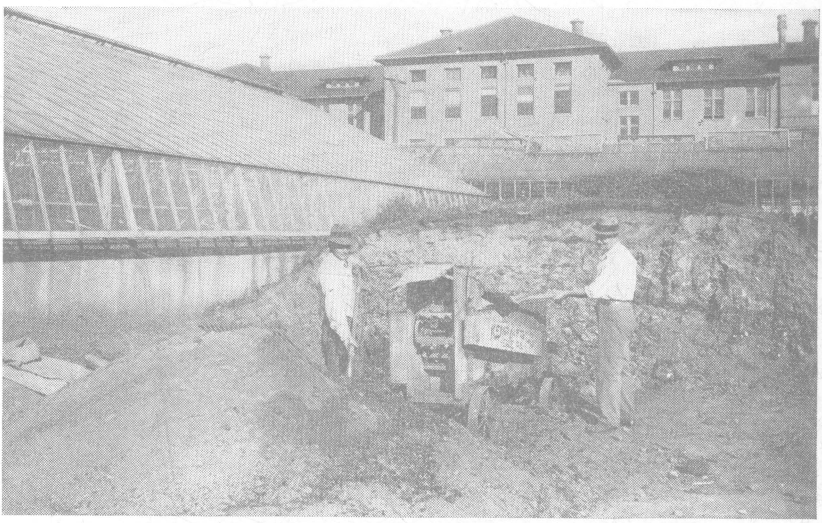

Fig. 3.—A compost pile showing shredding machine.

soil will need to be aerated for 10 to 12 days before it is planted. The walks and sash and other parts of the plant-growing equipment should also be washed with the formaldehyde solution.

Preparation of Soil

Composts.—Soil for plant growing can be prepared by composting alternate layers of soil and manure. The compost pile should be from 8 to 10 feet wide and as long as desired. Four 1-foot layers of each kind are used beginning with soil and topping with manure. Enough manure is used in each layer so that it can be tramped to a depth of one foot. The best soil is obtained from a sod field. Soil from woodlots is usually heavily infested with rhizoctonia.

A finished pile is built low in the center so that it retains water. This compost pile is made a year in advance of the time needed and it is turned three or four times. Each time the outside of the old pile is turned toward the center of the new pile. Enough water is added to make the compost moist but not enough to drench it. The compost is run through the soil shredder as needed. This machine tears it up and mixes it well. The resulting compost makes the very best kind of soil in which to grow plants.

Where manure is not available a good soil can be made by mixing artificial manure with a fine sifted soil. The possibilities of making artificial manure by treating straw, cornstalks, and similar materials with nitrogen to hasten decay seems worthy of the attention of gardeners. For a ton of straw, the bottom of the pile should be about 10 feet square. A layer of straw, 1 foot deep is well tramped and watered, after which it is treated with about 30 pounds of a mixture containing 50 pounds of sulfate of ammonia, 40 pounds of superphosphate and 100 pounds of ground limestone. This process is repeated for each of the six layers required to use up 1 ton of straw. The top of the pile is made to slope toward the center so that rain or added water runs into it. In the absence of adequate rainfall, water must be added from time to time to keep the pile moist throughout and to prevent heating. About 3 tons of manure of excellent quality are thus produced from 1 ton of straw. Best results are secured if coarse material such as cornstalks are shredded before being placed in the heap.

Dampen the straw on each layer, as it is packed down. When the pile is complete, water it well but do not put on enough water to cause leaching. Repeat the watering of the pile about every other day for 12 to 14 days, taking care to prevent much leaching from the pile. Then let stand 5 or 6 weeks when the whole pile should be forked over in another similar pile and let stand until straw is decayed. This turning of the pile is for purpose of aeration. Three or four months are required for making this artificial manure during the summer. If a pile is made up during early fall the manure will be ready for use the following spring.

Soil for Plant Growing.—Composted soil is ideal for hotbeds and coldframes but where extensive plantings are made, it is not always available. Sandy soils are preferred because of the ease with which they permit root systems to develop. Such soils hold together well during the process of moving plants to the field.

Flats.—The use of flats in sowing seed is a well established practice. These flats are made of light wood and the dimensions are about 2½ x 12 x 18 inches. The bottoms are slatted or screened. A layer of coarse material keeps fine soil from dropping through the openings. Then the box is filled with a sifted compost or other plant-growing soil. These flats can be placed in either the coldframe or the hotbed. They are easily moved from one place to another without disturbing the root systems of the plants.

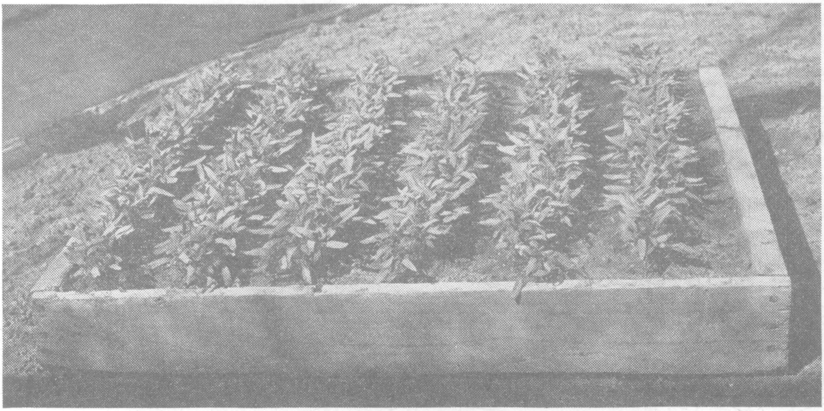

Fig. 4.—Growing plants in flats like this one makes it easy to move seedlings from one place to another. From 500 to 1000 seedlings can be started in a flat like the one shown above.

Seed Sowing

Seed is usually sown in rows at least 3 inches apart. This practice allows sunlight to penetrate the foliage better than if seed is broadcast and it also aids the surface soil to dry quickly and help in controlling damping off. Six to eight seedlings may be grown in each inch of a row. The less crowded the seedlings the stockier will be the plant. Lifting plants and separating their root systems is made easy by growing them in rows. Small seeds, such as cabbage and tomatoes, are planted ¼ to ½ inch deep. Large seeds, such as melon, are planted directly into pots, veneer bands, or inverted sods.

After the seed is planted, water should be applied as a fine spray, but, to prevent washing of small seeds, cover the flat with burlap before applying water. This burlap will help retain moisture but should be removed as soon as the seed has germinated.

To provide better conditions for germination, especially during bright sunny weather, the seed bed soil is covered with paper or glass. This kind of a cover prevents rapid evaporation of moisture from the seed bed and helps to maintain a uniform temperature. As soon as the seeds germinate and reach the surface of the soil, these covers are removed.

Time of Sowing Seed.—Tomato plants can be produced in from 8 to 10 weeks. There is a tendency to sow seed too early, thereby getting the plant to the field stage before it can be safely set in the field. It is then necessary to hold the plant in check. The first ripe fruits may come from hardened plants but the number of fruits which are of first grade quality will be relatively small. The bulk of early marketable fruits will be much smaller from hardened plants than it will be from tender plants. Tender plants, besides being more profitable, can be produced with less expense.

A fine, stocky tomato plant about 10 to 12 inches high with the first blossom cluster well formed but not opened is the most profitable kind of a plant to set in the field. Good cabbage plants

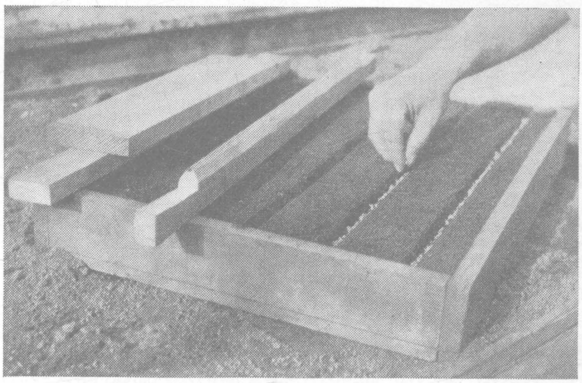

Fig. 5.—Sowing seed in a flat. Rows are 3 inches apart and are made the long way of the flat.

can be produced in from 6 to 8 weeks. Cabbage is less affected by hardening than the tomato. It is much safer and easier to force plant growth than to retard it.

The chart on pag 9 gives in detail the method of growing plants used in Ohio.

Transplanting

Transplanting probably does not benefit the development of a plant, but it is not practical to grow early crops without transplanting. It is necessary to start the plants under protected conditions and the grower can do this most economically by having a special bed for germinating the seed. Seedlings are transplanted from this bed to allow more space for each plant to develop.

Seedlings are ready for transplanting when they have formed two or three true leaves and before they become overcrowded. In lifting seedling plants, an attempt is made to keep as much of the

DATES FOR SOWING VEGETABLE SEEDS UNDER GLASS

VEGETABLE	Number of weeks to sow seed previous to setting in the field	Age of seedling when moved to coldframe Weeks	Spacing in cold-frame	MOVE PLANTS TO FIELD		
				Northern Ohio	Central Ohio	Southern Ohio
Tomatoes	8 to 10	2 to 3	4″ x 6″	May 25	May 15	May 10
Cabbage (early)	6 to 8	1 to 2	2″ x 2″	April 10	April 1	March 25
Cauliflower (late)	4 to 6	None	None	July 1	July 15	July 20
Brussels Sprouts	4 to 6	None	None	July 1	July 15	July 20
Kohlrabi	4 to 6	1 to 2	2″ x 2″	April 10	April 1	March 20
Lettuce (leaf)	4 to 5	1½	2″ x 2″	April 10	April 10	April 1
Lettuce (head)	6 to 8	1½	2″ x 2″	April 10	April 1	March 20
Beets	6 to 8	None	None	April 10	April 1	March 20
Celery (early)	10 to 14	4	2″ x 2″	May 1	April 20	April 10
Celery (late)	10 to 14	4	2″ x 2″	July 1	July 15	August 1
Eggplant	10 to 12	2 to 4	2″ x 4″	May 25	May 15	May 10
Pepper	10 to 12	2 to 4	2″ x 2″	May 25	May 15	May 10
Melons	4	None	None	May 25	May 15	May 10
Cucumbers	4	None	None	May 25	May 15	May 10

root system intact as possible. It is well to set the seedlings down almost to the seed leaves (cotyledons). The soil about the plant should be firmed well. This reestablishes a direct contact between the plant roots and the soil.

Fig. 6.—Early tonnage as well as total tonnage is greater from plants that are set in the field with the minimum of root disturbance. Tomato plants spaced as closely as those shown in the picture cannot be moved to the field without considerable root injury.

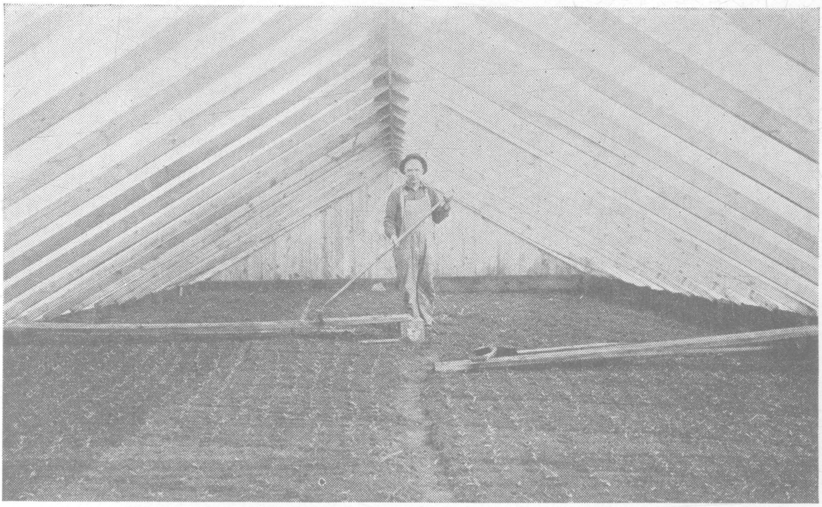

Fig. 7.—Tomato seedlings widely spaced in one of the new type muslin-covered, flue-heated, coldframes. Such spacing allows the plants to be "blocked" and moved to the field with a minimum of root disturbance.

Cultural Operations

Cultivation.—If compost is used in coldframes and hotbeds, very little cultivation will be required to keep the soil loose and in good tilth. The real object of cultivating the soil in the coldframes and hotbeds is that of weed destruction. They should be removed from the plant beds.

Fertilizer.—If a compost soil is available it should be supplemented with 20 per cent superphosphate applied at the rate of 500 to 600 pounds per acre. In case a compost soil is not available a complete fertilizer should be used. A 4-12-4 is applied at the rate of 1000 pounds per acre.

Plant Spacing.—During recent years there has been a very decided movement among vegetable growers to provide more space per plant in the coldframe. The chart on page 9 gives the recommended spacing distances for all vegetables grown under glass and in the coldframe. Perhaps the chief reason for more space in the coldframes is that such a practice permits the development of the

Fig. 8.—Plants grown in a veneer band and a clay pot. Note size of plants and the root extending from the veneer band.

root system in proportion to the top growth. This system also allows the grower to move his plants from the coldframe to the field with the minimum amount of root disturbance.

Handling Plants in Pots or Bands.—The **best** way to grow plants is in pots. Growing them in veneer bands is next best. However, there is danger of the plants becoming root bound in clay pots if not set to the field at the proper time. Also veneer bands are less expensive than clay pots and plants grown in them do not become root bound, although some roots are lost when plants are grown in veneer bands.

The bands are shipped in bundles of 1000. These are soaked in water before they are bent into shape and stapled. This can be done during the winter months. In preparing the bands for planting a layer of fine soil is placed in the bottom of the bed. The bands are placed in the bed side by side and filled with soil. The seedling plants are then transplanted into the bands.

Blocking Plants.—The method of "blocking" tomato plants is as follows: The seedling plants are set in the coldframe about 4 to 6 inches apart each way. The soil in the coldframe is usually 4 inches deep and under this is a 1- to 2-inch layer of decayed

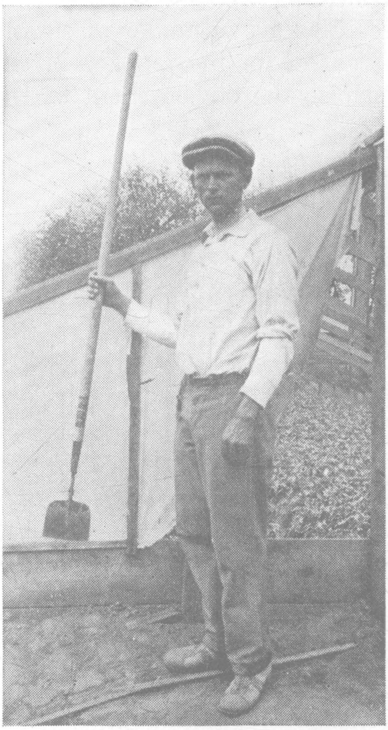

Fig. 9.—A straightened hoe used in "blocking." A long, sharp knife can also be used.

Fig. 10.—A "blocked" tomato plant removed from the cold-frame some 26 hours previous to the time the picture was taken.

straw or manure. Ten days before the plants are to be moved to the field a sharp tool is used to cut in one direction between the rows. Three days later the blocking is completed by a second cutting made at right angles to the first.

The cut needs to be through the soil and through the layer of organic material underneath the soil. After each of these cuts, the plants may wilt a little, in which case, they should be given a light watering. Cutting between the rows of plants with a very sharp tool severs the interwoven root systems of the adjoining plants. Clean, sharp cuts made in this way will allow the root systems to callous over in a few days. This will bring about the development of hundreds of new, fine, hair-like roots. These, in turn, will bind together the soil with which they come in contact. The plants should be thoroughly watered a few hours before they are lifted. These "blocked" plants can be lifted from the coldframe by the use of a flat fork or spade, placed on a sled and taken to the field. The lifting tool should be the exact width of one or more of the blocked plants.

Setting the plants in straight rows makes it easy to block them. A spotting board can be used to set the plants in even, straight, uniformly spaced rows.

Watering.—Water the plants in the coldframe and hotbed enough to keep them from wilting. There is danger in supplying too much water to the plant beds. Lack of water causes the plants to wilt and checks to the growth. When carried to extremes the lack of water will cause plants like the tomato to become woody at the surface of the soil. Such woody plants when placed in the field will produce a few small cull fruits on the first cluster. However, the second cluster will yield satisfactory quantities of high quality tomatoes.

When watering, apply enough to last for several days. It is also advisable to wait for a bright morning to make such an application. Then, the plants and the surafce of the soil will dry off quickly.

Temperature.—Both warm-season and cool-season crops can be grown at a temperature as low as 40° to 45° F. There is danger however of such plants as celery, beets, onions, cabbage, and cauliflower going to seed because of cold weather during the first part of the season. The best way to grow the cool-season plants is to force them along at temperatures of 50° F. at night and 60° F. during the day. The warm-season crops are best pushed along at a night temperature of 60° F. and a 70° F. day temperature. A later start in the plant beds and a faster growth will give better results than a slower development over a longer period of time for tomatoes, peppers, and eggplants.

Plants can be grown slowly by holding them at a low temperature. The rate of growth of a plant can also be retarded by cutting off the plants' water supply. Ideal conditions in the plant bed for the uninterrupted growth of the plants may be had by following the dates suggested in the chart for sowing the various vegetable seeds. Plants will be ready to set in the field at the right time and will usually not need to have the growth of the plant speeded up or retarded at the time.

Ventilation.—To maintain the desired temperatures in the plant beds, it is necessary to provide plenty of ventilation just as it is necessary to provide a supply of heat during cold days. Under Ohio conditions, it will be more difficult to keep the temperature of the plant beds down during the last week or two than it will be to maintain the heat supply needed during the colder weather. The

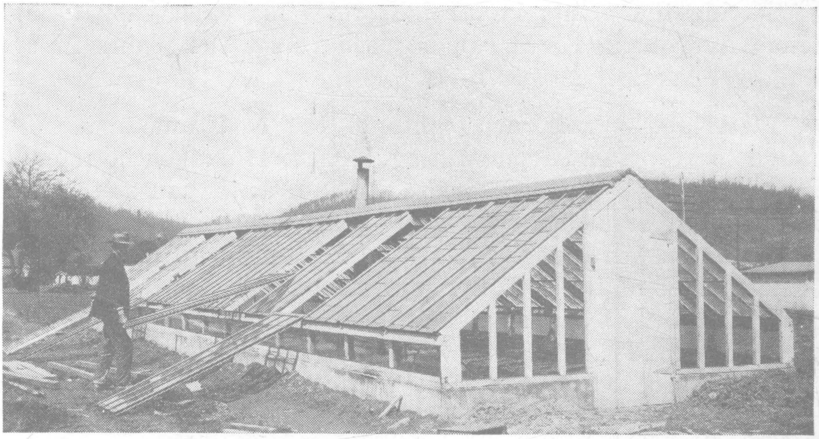

Fig. 11.—Plenty of ventilation is needed in the plant beds. This new type of sash-covered hotbed is easily ventilated.

growing plants require fresh air, but they must not be exposed to sudden changes in temperature. Water given off by the plant and collected on the foliage is an indication that the ventilation is poor. If it is possible to prevent this water of condensation from collection on the leaves, it should be done.

Hardening.—Plants are handled in the coldframes so that when the time comes to set them in the field they will be prepared to withstand outdoor temperatures. During the last six or seven days of the plant's development in the coldframes, the muslin covers should be kept rolled up, at least during the day time. The last day or two the covers are entirely removed if weather conditions permit.

Disease Control.—Tomato, pepper, and celery plants can be sprayed with 4-6-50 bordeaux mixture at intervals of six or seven days while they are in the plant beds. The first spray is applied at the time the seedlings are transplanted to the coldframes. Such a procedure will aid in the control of early and late blight which is so disasterous to the tomato crop. For further information concerning the control of diseases in hotbeds and coldframes, see Bulletin 76, Ohio State University, Agricultural Extension Service.

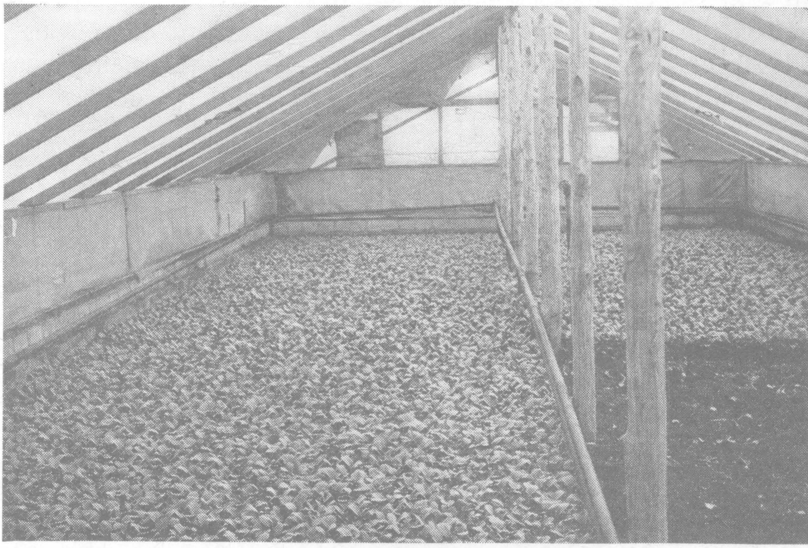

Fig. 12.—Cabbage plants ready for the field. They are 8 weeks old and were set in the field April 1.

Setting Plants in the Field

Root Pruning and Top Pruning.—Root pruning and top pruning are both unprofitable practices. Root pruning destroys the balance between top growth and the root growth necessary for steady unchecked development and top pruning will increase the opportunity for the spread of such diseases as Mosaic.

Lifting vs. Pulling.—When seedlings are moved to the coldframe or when plants are moved to the field, every precaution needs to be taken to see that as few as possible of the fine root hairs are lost. Some plants, like the melon, cannot stand rough handling. Other plants, such as the tomato, can live under almost any condition. The plants will always respond best to careful handling.

Plant-Growing Structures and Heating Equipment

Location.—Hotbed and coldframe structures should be located conveniently for the workmen, near a good supply of water, and preferably sheltered by a wind break. Plant-growing structures need to be so located that they will receive the maximum amount of sunlight available in the early season. A well drained site will make the hotbed and coldframe more efficient and earlier.

Types of Construction.—Some hotbed and coldframe structures are made of wood. Some of them are constructed in such a way that they can be moved from one site to another very easily. Then there is the more permanent structure, usually made of concrete or brick or a combination of the two. This permanent type of

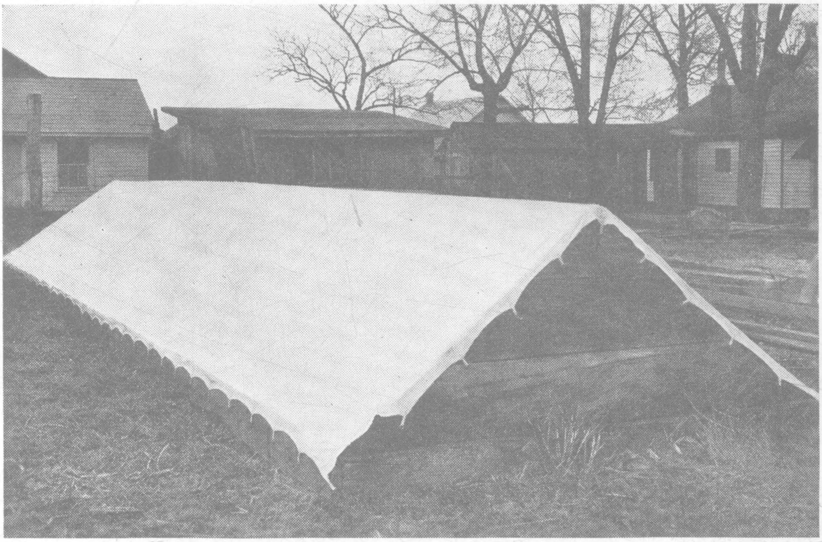

Fig. 13.—A conveniently located muslin-covered coldframe.

structure needs to be very carefully located and handled. The soil in the permanently located structures is likely to become contaminated with diseases and insects after a year or two.

Covers for Hotbeds and Coldframes.—Glass or muslin covers are used on the several kinds of plant-growing structures. During extremely cold weather additional protection may be needed. This can be provided by using rye straw mats, burlap, or loose straw. Glass covers are the most durable and, if given proper care, will last from 20 to 25 years. Clean glass admits the maximum amount of light. Glass is easily replaced and is not readily blown about by the wind.

Muslin covers are used extensively on coldframes late in the season when the weather is moderated. A good heavy grade of muslin should be used and it needs to be large enough to provide an overlap on all sides of from 6 to 12 inches.

There are glass substitutes on the market which seem satisfactory but they are expensive and will only last a year or two if exposed to severe weather conditions.

Types of Heating

Manure Heat.—Fermenting manure is used as a source of heat for the surface and pit types of hotbeds. Fresh, strawy, moistened horse manure, is piled near the hotbeds a few days before they are to be started. Fermentation usually starts at once and the manure will be ready to place in the hotbeds in a few days.

Fig. 14.—Four types of plant-growing equipment. Muslin strips, sewed every 12 inches along the edges of the muslin covers, are used to tie it securely in place.

If the manure is to be used for surface hotbeds, it is placed in piles from 10 to 14 inches deep and 2 feet wider than the hotbed frame. If the manure is placed on the pile in thin layers and tramped evenly, it will furnish a moderate supply of heat for a long period of time. A loosely tramped pile of manure will give higher temperatures during a shorter period of time.

Where a pit botbed is built, much less manure is required. Pit hotbeds are prepared by excavating the soil to a depth of 18 to 24 inches. The pit is slightly larger than the frame of the hotbed and it is well drained. Manure is packed in the pit in thin layers until the manure is 12 to 18 inches deep. Special precaution is taken to see that the corners are well tamped.

Steam Heat.—Where steam is available the hotbeds are provided with two lengths of 4-inch drain tile laid 10 inches under the surface of the soil and extending the length of the hotbeds. These tile lines are laid 18 inches from either side of the beds which are 6 feet wide. The joints are not cemented together. The steam

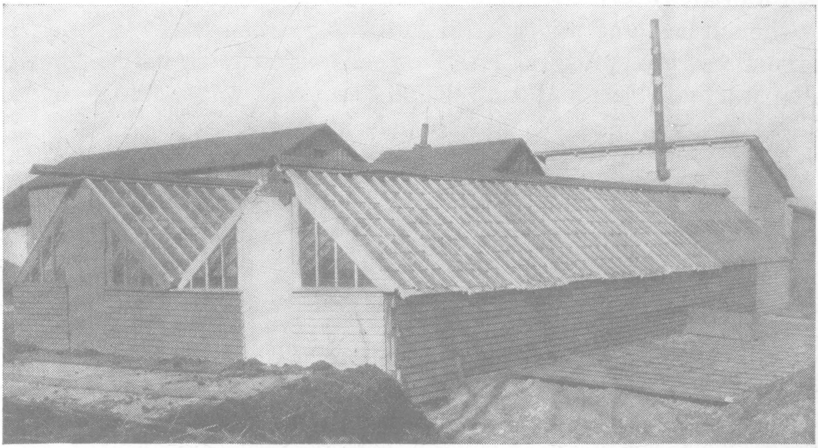

Fig. 15.—A sash-covered plant house and heating shed. This house was heated with the hot water heater shown on page 21.

enters the tile lines at a point about two feet beyond the ends of the bed. Steam is forced into these lines for 10-minute periods. From one to five of these periods are needed each day, depending upon the outside temperatures. Such a system of hotbed heating has

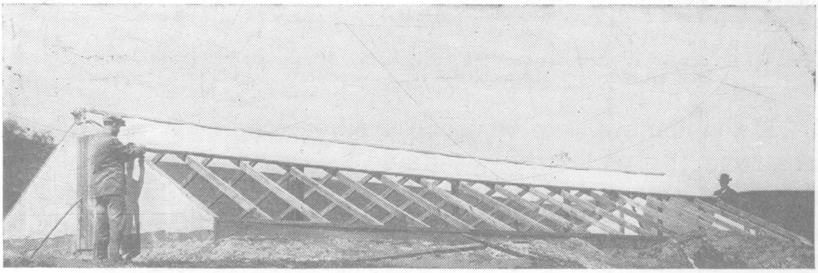

Fig. 16.—Rolling a muslin cover on a flue-heated coldframe.

been very satisfactory. A combination system of hotbed heating and sterilization can be provided. (See Steam Sterilization, page 3.)

Hot Air.—An ordinary heating stove can be used to warm the plant house. The stove is placed at one end of the house and the

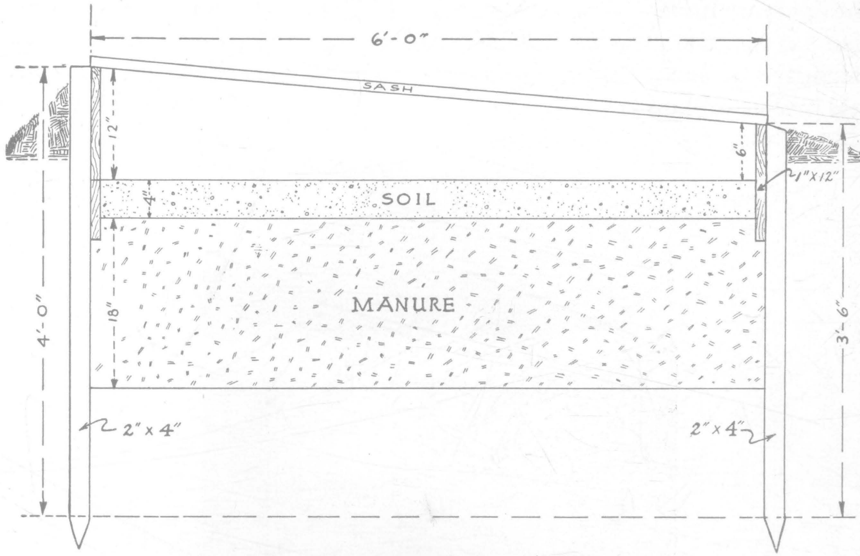

Fig. 17.—Cross section of pit style hotbed.

smoke is carried through a pipe to the smoke stack in the opposited end.

Hot air can be used in place of steam in tile lines for heating hotbed soil but 6-inch tile are used in place of 4-inch tile. Where this system is used to heat plant houses, the tile lines are laid on

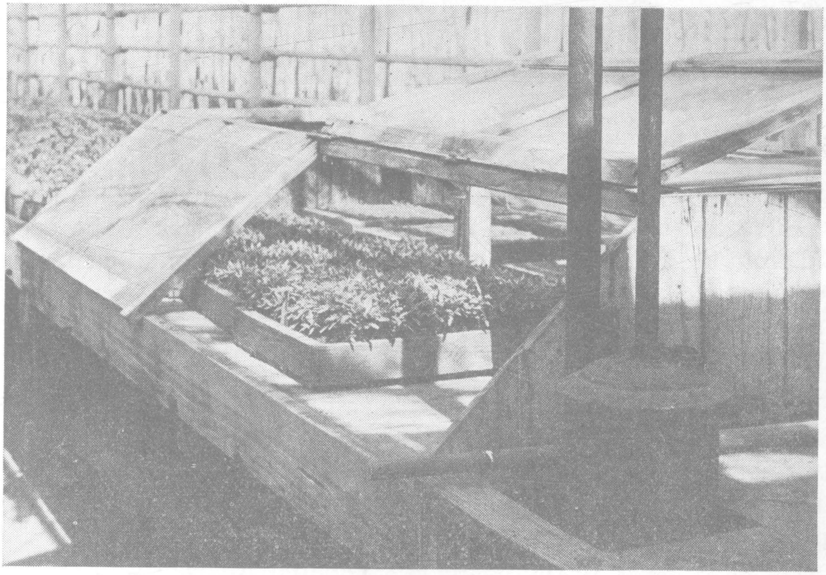

Fig. 18.—A seed germination box used to shorten the germination period of the seed. A miniature hot water heating plant is used to obtain bottom heat.

the ground under the plant benches. There should be a gradual rise in the tile line to insure good draft, and the tile lines are cemented at each joint to prevent the smoke and gases from escaping into the plant house.

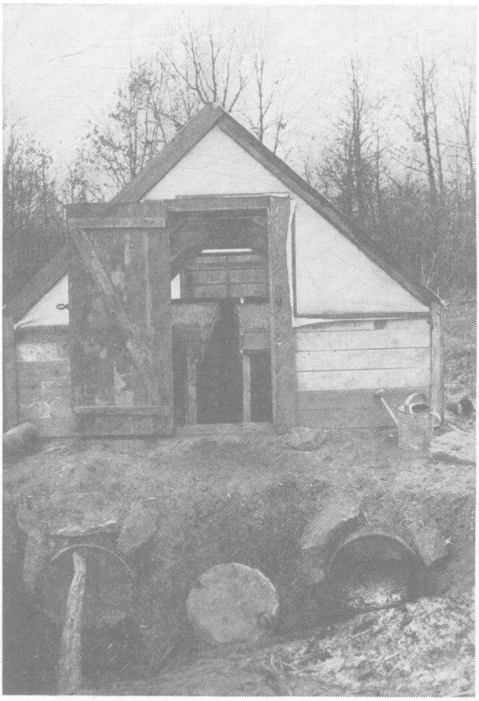

Fig. 19.—End view of a flue-heated, sash-covered plant house.

The fire box is located at one end of the house. The tile is laid from the fire box along one side, across the end and back along the other side to a smoke stack. The size of the fire box depends on the kind of fuel used. They can be built with stone, brick, or old oil drums.

Hot Water.—The hot water heating system is the most satisfactory because it supplies a uniform heat with the minimum of attention. Inexpensive, hot-water heaters are available that have automatic draft regulators. The size of the heater needed depends upon the number of square feet of exposed surface. It is best to purchase a larger heater than is estimated to meet the requirements.

The accompanying diagram shows the main essentials of a hot-water heating system. It is important to place an air valve at the highest point in the system to release air or steam. All pipe lines should have a gradual slope from this high point back to the heater.

Fig. 20.—A self-regulating type of hot water heater that has proved satisfactory for heating small greenhouses.

It is also necessary to provide an expansion tank. This tank is located above the highest point in the system and is connected with the return pipe line just before it enters the heater. The top of the hot-water heater is about level with the lowest return pipe.

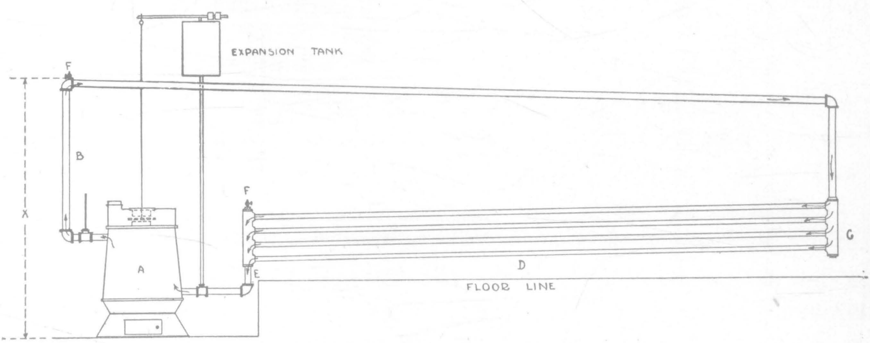

Fig. 21.—Plan for a hot water system for small greenhouse.

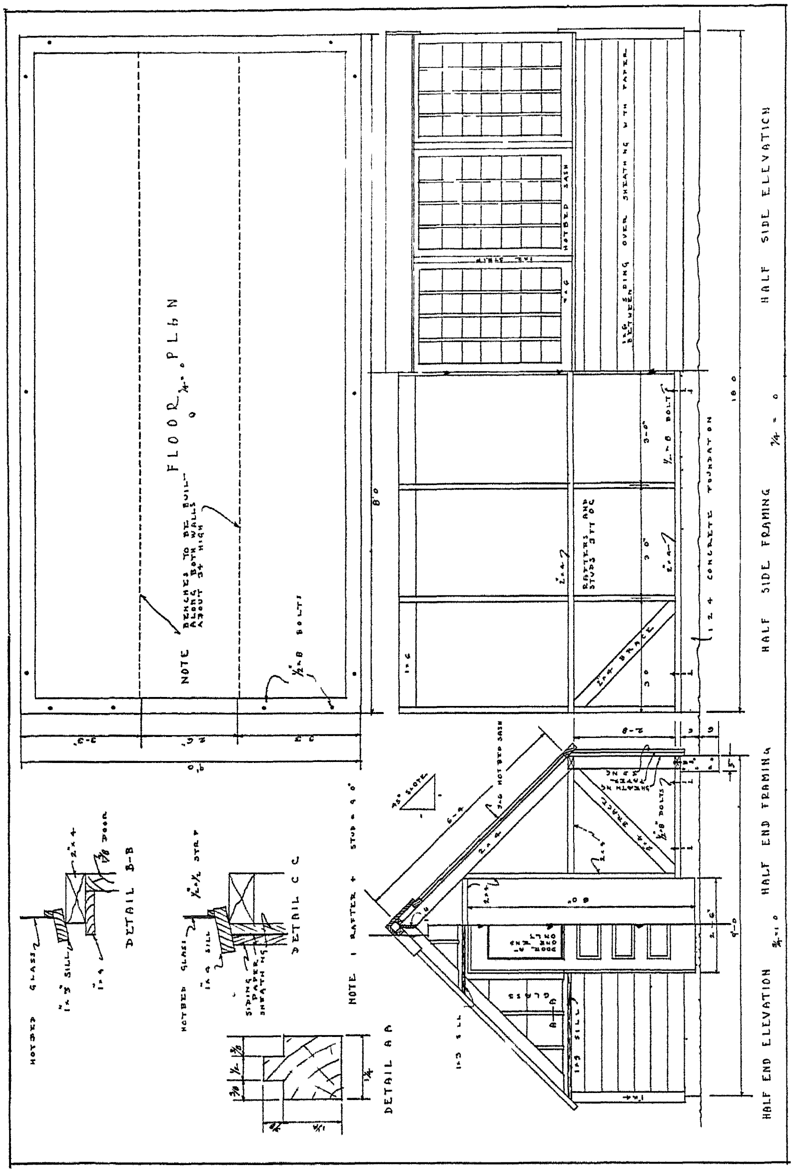

Fig. 22.—Sash-covered plant houses can be made smaller or larger on this same plan.

A reducing nipple is needed between the flow pipe and the return pipe to give even distribution of heat in the return lines.

Sash Houses

During the past two or three years, sash-covered, heated plant houses have been generally substituted for manure-heated hotbeds. A 9′x18′ sash house has been designed to cost less than $100. The drawing shown in Fig. 22 calls for a cement foundation, but this can be substituted by setting the house on blocks or by setting the side posts in the ground. The cost of construction can be reduced by the use of material that may be on hand. The following is a list of the material needed:

House Proper

4–18′ x 2″ x 4″—side base and eaves
1–18′ x 1″ x 6″—ridge pole
16– 9′ x 2″ x 4″—rafters, side posts, end base and eaves
18′ x 1″ x 4″—end sills
2–18′ x 1″ x 12″—cover for ridge roofing
150 board feet sheathing
150 board feet groved sheathing
1 2½′ x 6′—door
1 2½′ x 6′—door case
12 3′ x 6′—hotbed sash

Bench

2 10′ x 2″ x 4″ } legs and cross pieces
2 14′ x 2″ x 4″ }
150 board feet sheathing
6 sacks of cement
1 roll insulating paper
12 ½″ x 8″ bolts
Hinges, hooks, nails, etc.
1 box glass for ends

Capacity of 9′ x 18′ Sash House

20,000 seedlings—rows 3″—plants ¼″ in rows
3,800 plants—2″ x 2″
1,700 plants—3″ x 3″
900 plants—4″ x 4″

This 9′x18′ sash house can be built wider and longer to suit the needs of the particular case. The pictures of sash covered houses shown in this bulletin were all made by altering the original plans.

Muslin-Covered, Flue-Heated Frames

Muslin-covered frames of various sizes are used. A lot of space is needed to grow transplanted plants and it can be provided economically and conveniently by this type of structure. See Figs.

25 and 26 for details of construction and heating plans for one of the popular-sized houses. The following is a bill of material for a 40-foot frame:

A. For flue-heating system:

380′ of 4″ drain tile for cross lines
24′ of 6″ fire clay tile for lead-in lines from fire boxes
36′ of 8″ sewer tile for header line nearest fire boxes
40′ of 8″ drain tile for header line nearest smoke stack
18′ of 8″ sewer tile for smoke stacks
4 old oil drums for fire boxes

Fig. 23.—Laying tile for the flue-heating system of a muslin-covered plant-house.

B. Lumber for coldframe

358 board feet of 1″ rough lumber
22 rafters 2″ x 4″ x 12′
6 posts 4″ x 4″ x 9′
12 stakes 2″ x 4″ x 4′
1 ridge pole 2″ x 4″ x 40′
2 side sills 2″ x 4″ x 40′

C. Muslin covers (each cover to be one solid sheet)

1 cover of tobacco cloth (28′ x 42′ when completed)
1 cover of heavy muslin (28′ x 42′ when completed)
2 iron pipes (1½″ x 41′) each
2 iron pipes (1½″ x 1′) each
2 iron elbows (1½″)

Construction.—The side walls of the coldframe are from 18 to 24 inches high, and are made of rough lumber. No attempt is made to have them air-tight. The ridge pole is from 6 to 7 feet high and the rafters, placed every 4 feet, are made from 2″x4″ lumber. Galvanized wire can be used in place of wooden rafters. Rusty wires will need replacing in order to save the muslin covers from unnecessary wear.

Fig. 24.—A muslin-covered, flue-heated, coldframe and a flue-heated, sash-covered, hotbed.

Muslin Covers.—One or two muslin covers can be used on each house. The first cover may be of light muslin, or tobacco cloth. The outer cover should be of a good heavy grade of muslin. Each cover is to be in one piece and the seams should be double sewed. Each side of the cover should be tacked to a roller made from nar-

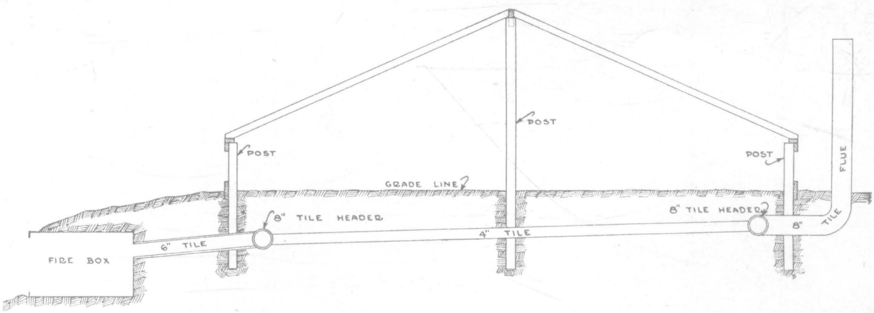

Fig. 25.—Diagram showing method of laying tile for a flue-heated, muslin-covered plant house. Height of ridge pole is 6 feet, side walls are 2 feet high, and width of structure is 22 feet.

row strips of boards. This is best done by tacking opposite sides of the muslin cover on 1- by 2-inch strips, placed end to end. Roll the strips twice and then nail the same sized strips to the first ones, making sure that the joints are broken, so that the pole will be strong and rigid. Iron pipe can be used as a roller if it is first painted with a rust-proof paint.

Light ropes or even chalk lines may be placed over the muslin cover and fastened to each roller. These ropes may be located over each rafter or over every other rafter. Then, when the wind gets under the muslin, the pull will be on the ropes and not wholly on the cover. When the cover is rolled up, the ropes are rolled up with it.

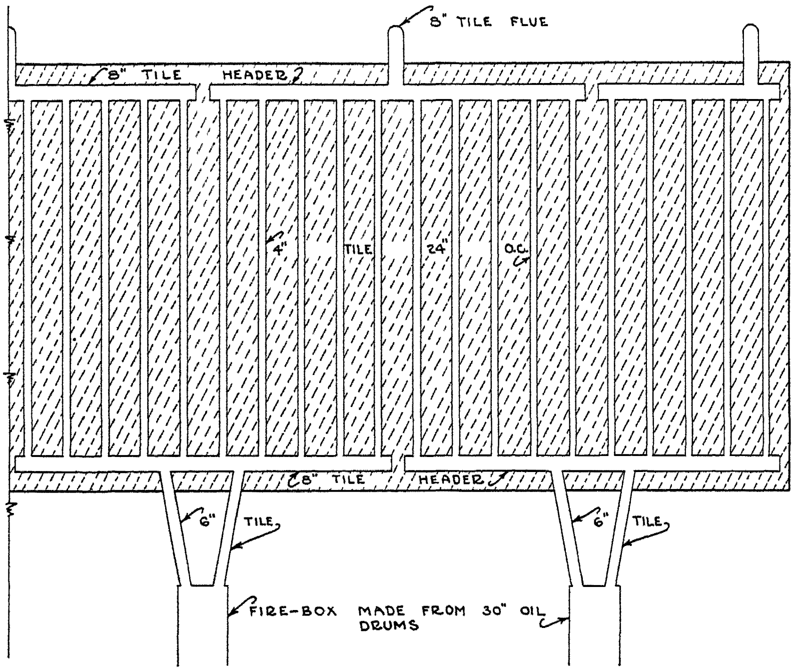

Fig. 26.—D:agram showing the spacing header and cross tile lines in the flue-heating system used for muslin-covered plant houses.

Heating.—The heating system for a coldframe is used to warm the soil before the seedling plants are transplanted. After that it is used only in case of unfavorable weather.

To insure the correct circulation of warm air in the flue heating system shown in Fig. 26, the header tile lines are blocked at a point half-way between each fire box and smoke stack. This forces the smoke and heat to circulate in a definite part of the coldframe. Too much draft in the lines is prevented by placing a damper in the stacks and by closing up the fire box with sheet iron. Hot water or steam heating systems can also be used in this type of house.

Bulletins for Vegetable Growers

Extension Bulletins and Circulars

Extension Bulletin 86, Potato Growing in Ohio
Extension Bulletin 76, Control of Garden Insects and Diseases.
Extension Bulletin 75, Mexican Bean Beetle
Ohio Farm Gardens
The Vine Crops (Melons and Cucumbers)
Fertilizers for Vegetable Crops
Correspondence Courses

The bulletins and circulars mentioned above and prepared especially for Ohio growers may be had by writing to the Publications Department, College of Agriculture, the Ohio State University, Columbus, Ohio.

The following bulletins may be secured from the Ohio Agricultural Experiment Station, Wooster, Ohio.

Ohio Agricultural Experiment Station Bulletins

Bulletin 447, Paper Mulch for the Vegetable Garden
Bulletin 399, Relation of Weather to the Dates of Planting Potatoes in Northern Ohio
Bulletin 430, The Normal Multiple Sprouting of Potatoes
Bulletin 432, Ohio Potato Diseases
Bulletin 420, Fertilizers for Early Cabbage, Tomatoes, Cucumbers and Sweet Corn
Bulletin 433, Farmers Produce Markets in Ohio

The College of Agriculture and the Experiment Station are your institutions. Call on them when wanting help.